GOVERNMENT OF INDIA

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE

BARRACKPORE

.....

Annual Report for the year 1960-61.

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ANNUAL REPORT OF THE CENTRAL INLAND FISHERIES RESEARCH INSTITUTE, BARRACKPORE, FOR THE YEAR 1960-61.

G E N E R A L

Substantial progress was achieved during the year in all investigations undertaken by the Research Institute. There was also an all round expansion of activities of the various sections and units, under both normal and Second Five Year Plan Programmes.

During the year under report 6 additional residential quarters were constructed at Barrackpore at a cost of Rs.1,22,200/-. An area of 35.25 acres of land was acquired for the establishment of an experimental fish farm in Kakdwip. The construction of Garage, Workshop and Stores at Headquarters was sanctioned at an estimated cost of Rs.1,31,000/-. Sanction for the construction of an aquarium at a cost of Rs.99,615/- has also been received from the Government.

The draft proposals for the implementation of the Third Five Year Plan Programme were submitted to Government.

The following officers were appointed during the year.

1.	Dr. Y.R. Tripathi	-	Research Officer(Sr. Grade)
2.	Dr. H. Chaudhuri	-	Research Officer
3.	Sri V.R. Pantulu	-	Research Officer
4.	Sri R.M. Bhowmick	-	Assistant Research Officer
5.	Sri A.K. Basu	-	Assistant Research Officer
6.	Sri Thomas Joseph	-	Administrative Officer

Dr. T.V.R. Pillay was relieved of his duties at this Institute on 14.4.60 (AN) to take up the post of the Deputy Director (Fisheries Extension) at the Ministry of Food and Agriculture on the recommendations of the Union Public Service Commission.

Training :

The 13th Session of the Inland Fisheries Training Course commenced on 1st April 1960 at Barrackpore with a total of 28 trainees, comprising of four Colombo Plan trainees under Technical Cooperation Scheme of the Government of India (one each from Philippines and Nepal and two from Malaya), Sixteen State Government deputees and stipendiaries from Uttar Pradesh, Bombay, Madhya Pradesh, Punjab, Andhra Pradesh, Orissa, Assam, Tripura and Himachal Pradesh and eight private candidates from Madras, Uttar Pradesh, Madhya Pradesh, Bombay, Kerala, Bihar, West Bengal and Andhra Pradesh. At the final examination held in January, 1961 one candidate was placed in the first class, 14 in the Second Class and 13 in the Third Class.

A Refresher Course for the Fishery Officers of the C.D. and N.E.S. Blocks was conducted under the joint auspices of the Fisheries Extension Units at Calcutta and Gauhati and this Research Institute. Shri H. Banerjee, I.C.S., Development Commissioner, West Bengal, inaugurated the course on 22nd September 1960. Lectures and demonstrations were given to the trainees at Barrackpore by different specialists.

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Two Officers from Bombay Government Fisheries Department were deputed to this Institute for studying the techniques of induced breeding by pituitary gland injection.

A training course in deep water fishing in inland waters was conducted by this Institute at Maithon (West Bengal) from 15th to 30th October 1960 which was attended by 21 Officers from varicus States and Fisheries Extension Officers.

Meetings:

The Director attended the meeting of the Fisheries Committee of the Tungabhadra Board on the 23rd and 24th November 1960 and participated in the Fisheries Research Committee meeting held at Puri on 13th and 14th December 1960. He represented the Government of India at the 9th Session of the Indo-Pacific Fisheries Council held at Karachi (Pakistan) in January 1961. The Director also attended meetings at the Ministry in April and June 1960 in connection with the finalization of the draft Third Five Year Plan in so far as it relates to the Fisheries Schemes.

F.A.O. Fellow:

Miss M. Bryant, UNESCO Fellow from Liberia visited this Institute during the year and arrangements were made for her training.

F.A.O. Expert:

Mr. S.B. Gulbadamov, FAO Gear Technologist and the Russian Interpreter Mr. G.A. Semin continued to work at this Institute. After carrying out investigations in the Mettur Dam, Frishnarajasagar reservoirs and Damodar Valley Corporation reservoirs they left this Institute on 4th January 1961 after submitting their final report to Government. Dr. Y.R. Tripathi, Research Officer continued to work as under study during the period the foreign expert was assigned to this Institute.

Evaluation Audit:

Prof. H.S. Swingle, Rockefeller Foundation Expert, who was assigned to this Research Institute reported here on 25th January 1961 and left for Delhi on 8th March 1961 on completion of the evaluation work and submitted his report to Government.

Miscellaneous:

A representative collection of food fishes and a set of live fishes from the Central Inland Fisheries Research Institute and Molluscs from the Central Marine Fisheries Research Institute were presented by the Director to His Imperial Highness the Crown Prince of Japan on 8th December 1960 at Calcutta, on behalf of the Government of India.

Dr. H. Chaudhuri, Research Officer was awarded "Chandrakala Hora Gold Medal" by the National Institute of Sciences of India for his outstanding contribution in the field of fish breeding.

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Visitors:

Shri T.S. Gill and Shri Sadanand of the Planning Commission, Shri V.V. Kalyani, Director of Fisheries, Mysore, Shri Krishan Chand, Joint Secretary, Dr. David D. Keck of the National Science Foundation, U.S.A., Dr. N.K. Panikkar, Fisheries Development Adviser, Dr. B.N. Chopra, Fisheries Consultant, National Council of Applied Economic Research, Dr. K.T. Jacob, Director, Jute Agricultural Research Institute, Mr. N.I. Borisov, Russian Expert in Marine Fisheries, Dr. T.R. Bhaskaran, All-India Institute of Hygine and Public Health, Mr. Husanuddin Saanin, Head of Institute of Inland Fishery, Bogor, Mr. H.R. Mills, Director of Survey and Technical Training, Colombo Plan Bureau, Dr. P.V.R.Rao, Additional Secretary, Ministry of Community Development and Co-operation and a team of Officers, Mr. Wm. A. Dill, Chief, Inland Resources Section, Biology Branch of FAO, Rome and Dr. Richard L. Weaver, Associate Prof. of Conservation, University of Michigan visited this Institute during the year under report.

POND CULTURE DIVISION

2. Induced Breeding of Indian Carps

Pituitary glands were regularly collected from mature specimens of Common carp and other fishes as and when they were taken out for marketing. Over 200 glands were collected from the Calcutta Fish Markets and over 1,000 glands from Gwalior also.

Regular fish breeding work taken up during June at the Pond Culture Research Unit, Joysagar, Assam, resulted in Catla, Rohu, Mrigal, Calbasu and Gonius breeding by hormone injections and producing approximately 10 lakhs of spawn. One large Catla, weighing 14.5 Kgs. was successfully induced to spawn by a single injection at 5 mg./kgm. of pituitary material. About 20 lakhs of eggs were laid by the fish, 60% of which were fertilised. Two pairs of the catfish Ompok bimaculatus were also successfully induced to spawn by injections, producing over 24,000 hatchlings.

At Cuttack, experiments aimed at large-scale production of fish seed by injection of hormones were successfully carried out. At the beginning of the season (June) water conditions in ponds and channels were not very suitable for successful hatching of the eggs. These were overcome in July and successful spawning was obtained in 60% of the fishes (sets) injected. Of the successful cases, 40% responded to a single injection and 60% to two injections. The interval between first and second injections was generally 12 hours. The successful dose of injections were: single injection, 5-10 mgs./kg. and 2 injections, 7.5 mg. to 13 mgs. per Kg. About 138 lakhs of spawn of major carps were produced by injections. A large number of these were lost by hapas getting submerged in the river or getting torn in ponds. However, 81.85 lakhs of spawn could be obtained for stocking.

Of all the major carps, Rohu predominated others, as the number of breeders were more. The stock of Catla breeders was not satisfactory. Only 9 female Catla were available for the breeding experiments. The maximum weight of Catla female was 5.5 kgs. and it laid only about 5½ lakhs of eggs. The largest Rohu which bred successfully weighed 5.7 Kgs. and it laid nearly 10 lakhs of eggs, the percentage of good eggs being 95%. A female Mrigal weighing about 4.8 Kgs. laid 11.6 lakhs of eggs, of which over 90% hatched out.

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Experiments were conducted for the standardisation of injection doses also. Records of the sex, length, weight and stage of maturity of donor fishes were always maintained. Individual glands were preserved and weighed separately. The doses were calculated in mg. weight of the gland per kg. of the body weight of the breeders. Although it is very difficult to determine the exact stage of maturity in a female fish from external characters, attempts were made to select good breeders by rounded bulging nature and softness of the abdomen.

A good number of Rohu-Calbasu hybrids were observed to have matured fully. One set of the hybrid (two males and one female) was injected with Rohu pituitary gland. One and a half lakhs of eggs were obtained after the second injection of the female. Sixty five percent of the eggs hatched out. 40,000 of the hybrid spawn were stocked into a nursery pond and a few thousands were reared in the laboratory. These hybrids show great variations in colouration of the body, fins, barbels and in caudal spots.

Pituitary glands of spent fishes (by injection) were also successfully used to induce spawning in other species. It is generally believed that with spawning the pituitary glands lose their hormone potency and hence glands from spent fishes are generally not collected for injection purposes. But in the present instance the donor fish itself spawned in response to heavy dose of extra hormones and not by the action of the hormones in its own pituitary gland.

Progeny of Mrigal and Calbasu produced in 1958 by induced breeding became mature by 1960 July and were successfully spawned by administering hormones. The young ones are being separately reared to find out how they will respond when mature.

The usual technique of injecting the male and female breeders simultaneously was slightly modified with advantage. The female alone was given a very low preparatory dose of hormones and 6-8 hours later, a higher dose was injected into the female and the normal dose to the males. The injected fish were then put together in the hapa and in majority of cases spawning took place within the next 3-6 hours.

Adequate stock of breeders of all major carps have been gathered and kept in selected ponds for experiments during the 1961 season.

3. Breeding and Propagation of the common carp Cyprinus carpio

The scale carp (var. communis) continued to breed throughout the year. As there was demand for spawn during the monsoon season for mixed stocking with Indian carps, breeding on a limited scale was carried out during July - August also. The total quantity of spawn produced during the year amounted to 72,12,000, out of which approximately 62 lakhs were supplied to the Orissa State Fisheries Department.

In some of the breeding experiments, Kakabans made of Screw pine leaves and coconut fibre were repeatedly tried. Fishes spawned on the Kakabans and the eggs were sprayed on the upper surface only. Hatching of eggs, however, was poor as compared to eggs laid on weeds.

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Detailed work on selective breeding of the coloured specimens was taken up. When the male and female parents were coloured the young ones were also found coloured, though showing wide colour variations. The young ones so produced are being separately grown so as to stabilise desirable colours and combinations of colours.

It is commonly observed that amoung brood of Cyprinus fry, a few grow much more rapidly than others in the same pond. With a view to find out how this occurs, detailed studies on the size of eggs and hatchlings of fishes of different sizes, the size of eggs and hatchlings from lots laid at different times during spawning and hatchlings obtained at different hours from the same brood, were made. A short term study of the relative growth of selected fast growing specimens from one brood and slow growing specimens from another, (both of comparable length and weight) indicated that the fast growing ones are capable of better growth than the others.

During the period under report, fry and fingerlings of Common carp were supplied to the following agencies:-

Department of Fisheries, Orissa	2,71,609
Department of Fisheries, Punjab	12,880
Department of Fisheries, Mysore	5,000
Department of Fisheries, Pondichery	5,000
Department of Fisheries, West Bengal	33,798
Department of Fisheries, Assam	8,000
Tungabhadra Board, Hospet	5,000
Fisheries Extension Unit, Calcutta	1,300
Central Inland Fisheries Research Institute, Barrackpore	500
Private parties	4,000

4. Observations on the Mirror carp (Cyprinus carpio var. specularis)

During the year under report, mirror carps spawned twice. About 25,000 spawn obtained from the second fish have been reared in a nursery pond and about 5,000 advanced fry 1" - 1½" long were transferred to a rearing pond. They have now attained fingerling size and are to be distributed in stocking ponds.

5. Observations on Chinese Carps

Preliminary experiments using grass carps (Ctenopharyngodon idellus) to control natural growth of submerged weeds in nursery ponds have been encouraging. A pond (0.1 acre) fairly choked with Hydrilla could be completely cleared by 15 grass carps, each weighing about 0.226 kgms. only, in the course of one month. At the rate of 50 per acre the fishes could not effectively check growth of Hydrilla in another similar pond. When the growth of weeds is not thick, complete clearance in the course of a month will be obtained with 30-40 fish per acre. All weeds are not equally relished by the fish. Hydrilla, Lemna and Azolla are avidly eaten while Pistia and Naias are not favoured. Ottelia and Lagerosiphon are eaten to some extent. Leaves of Jussea are readily nibbled off. It has been observed that about 30 fish

weighing about 40.8 kgms. can easily consume about 27.2 kgms. of Hydrilla per day. The large quantity of weeds eaten is perhaps only partially digested and the quantities of semi-digested weeds sent out as faecal matter appreciably to the nutrients in the pond. Hence fairly thick plankton blooms are almost invariably found in the cleared ponds.

By March 1961 one specimen of grass carp, 530 mm. long and weighing 1.6 kg., was found to be mature and oozing milt on slight pressure on the abdomen,(Age of this fish was about 22 months only). The outer surface of the pectoral fin was found to have developed roughness. This is a clear indication that the fishes are likely to mature during the ensuing monsoon season.

Specimens of Silver carp (Hypophthalmychthys molitrix) have been showing better growth than the grass carp, the maximum size attained in 19 months (age 21 months) being 700 mm. and weight 4.15 Kgs. Two specimens examined on February 1961 were found to have developing gonads. The males had developed roughness on the outer surface of the pectoral fins. Indications are that these fish are likely to attain sexual maturity by the onset of monsoon in June-July.

A preliminary experiment on the growth of Silver carp was carried out to compare the same with that of Catla. Under identical conditions during a period of three months, the Silver carps were found to grow about 50% faster than Catla.

Three specimens of Big head (Aristichthys nobilis), which have come along with the silver carps, have been growing well - the biggest being 670 cm. long and 4.3 Kgs. in weight. All the three specimens appear to be females and by February 1961 they were found to be in a fairly well developed stage of maturity. This is clear evidence that the major species of Chinese carps could attain sexual maturity in our ponds when they are only about 2 years old.

6. Nursery operations

As spawning of Common carp continued throughout the year, the nursery ponds at Killa were put to use repeatedly for rearing successive crops. In the other ponds, only one crop of spawn was reared during July - August. All the ponds in Zobra, Puri and Choudwar could not be stocked. At Choudwar the entire stock of fry (6 lakhs) was washed off during high floods. The ponds at Linghipur and Kausalyaganga were stocked with relatively less fry for experiments on soil composition and on manureal value of selected chemicals. Stocking density was 2 lakhs/acre at Linghipur and 6 lakhs/acre at Killa.

All the ponds were initially manured with cowdung at the rate of 4 tons/acre. Mustard oil - soap emulsion was invariably applied to eradicate predatory insects. The fry were artificially fed with a 50:50 mixture of mustard oil cake and rice bran, at a progressively increasing rate starting from about 3 times the initial weight at stocking. The number of fry and fingerlings harvested are as follows :-

	Catla	Rohu	Mrigal	Common carp	Calbasu	Total
Killa	1,10,200	2,88,000	47,000	3,40,000	...	7,85,200
Zobra	...	1,25,000	1,95,000	...	5,300	1,49,800

	Catla	Rohu	Mrigal	Common carp	Calbasu	Total
Puri	...	5,21,000	...	75,500	...	5,96,500
Linghipur	....	34,000	...	...	...	34,000
Kausalya-ganga	....	1,71,650	...	...	...	1,71,650
						17,37,150

When the spawn produced from a pair of Catla was reared in nurseries, a good number of them turned out to be albinos. Instances of albinism in any of our carps are not known to have been observed before and hence the albino fry were segregated and reared in a separate pond. Nearly 50 specimens are now surviving and the maximum weight attained is 0.6 kg. in 8 months.

7. Fish production in rearing ponds

Three rearing ponds, each 0.2 acres in area, stocked with 1" - 1½" fry of Catla and Rohu were harvested after a period of 5½ months. Artificial food was given for two months in the beginning the quantity introduced being 40.8 kg. of mustard oil cake and 40.8 kg. of rice bran. The quantity of advanced fingerlings and yearling-size fish harvested from these ponds were 170.1 kg. and 158.8 kg. from two ponds in 5½ months and 136.1 kg. from the 3rd in 8 months. These work out to 1859.7 - 1723.6 kg. and 1020.5 kg. per acre per annum respectively and may be considered as very satisfactory.

8. Tilapia Investigations

Regular harvesting of Tilapia has been in progress continuously for the past 3 years and 7 months from a one-acre pond at Killa. No manuring or artificial feeding has been done and hence the harvest taken may be considered as natural production. With regular harvesting the size of the marketable crop is maintained higher.

Preliminary experiments on the use of Tilapia as a forage fish for the murrel, Ophicephalus striatus were carried out. While the experiments have to be repeated with various predator - forage ratios, it is found that murrels could effectively control the rapid multiplication of Tilapia.

Though mono-sex culture of male Tilapia was found to yield larger specimens for marketing, it was found that female Tilapia accidentally get into the ponds and start breeding. It has been found difficult to continue mono-sex culture for considerable periods .

9. Fish Culture in Paddy Fields

The experiment in 8 plots at the Central Rice Research Institute, Cuttack, was completed during the year. Common carp, Rohu and Catla fingerlings were used for stocking at a total density of 1,250 per acre. Common carp constituted 60% of the stock. Four months after stocking, the plots were harvested.

The maximum yield obtained was 37.2 kgs. acre, but wild fish constituted about half this. Common carp showed very low survival but excellent growth was recorded. Survival in the case of Rohu and Catla was better, but growth and production were relatively poorer than in Common carp. Further experiments will be arranged as soon as fields are prepared for the next crop of paddy.

10. WEED CONTROL INVESTIGATIONS

Further field trials indicated that ammonia is fairly effective against submerged weeds even when the ultimate concentration in the water is about 8.10 p.p.m. However, regeneration is more rapid than when the gas is applied at 15-20 p.p.m. The floating weed Wolffia and the emergent water lilies Nymphaea, Nelumbo and Euryale are also effectively killed by the gas. The cost of clearing weeds with ammonia worked out to approximately Rs.300-350 per hectare mater.

In preliminary yard experiments ammonium sulphate at 200 p.p.m. killed Hydrilla completely in 3 weeks' time. Superphosphate at 200 p.p.m. killed 95% of the plants. N-P-K at 200 p.p.m. encouraged the growth of filamentous algae without appreciably effecting Hydrilla.

In yard experiments, "taficide" (a new formulation of sodium 2,4-D) at 5.6 - 11.2 kgms./ha. killed water hyacinth and Pistia completely within 4-6 weeks. The 2,4 - Dichloropropionic acid preparation "Dowpon" was not found effective against Hydrilla grown in glass jars even at 50 - 100 p.p.m. Borax at 200 p.p.m. in cement cisterns did not have any sustained effect on Hydrilla. Aluminium sulphate applied at 50 p.p.m. in glass jars containing Hydrilla, after raising the pH of the water to 9 with shell lime, proved lethal to the plant. Further experiments have to be carried out for obtaining definite conclusions. Cobalt is under trial and has so far not shown any effect on Hydrilla, the strength used being upto 200 p.p.m.

A number of chemicals like Ferrous sulphate, Aluminium sulphate, Sodium chlorate, Sodium borate, Sodium 2,4-D (each at 225 Kgms./ha.), Strontium chloride, Sodium bismuthate, Ammonium carbonate, Barium chloride and Carbolic acid (each at 561 Kgms./ha.) were screened for their potential value as soil sterilants. Of these, Barium chloride alone gave complete suppression of the germination of Hydrilla turions. Others like Sodium 2,4-D gave partial supression.

Three stocking tanks at Kausalyaganga (each 0.5 hectare) infested with Hydrilla, Nais, Nymphaea, Nelumbo and Euryale were selected for studying the comparative effectiveness and economics of ammonia, urea and manual labour for clearing submerged and emergent weeds, one tank being used for each mode of clearance. 7-8 months after the start of the observations, there has been 5%, 10% and 15% regeneration of weeds in the tanks cleared with urea-cum-manual labour, with manual labour and with ammonia combined with some manual labour respectively.

A sample survey of the weed-infested waters of Andhra Pradesh has been taken up. Fortytwo bodies of water in nine districts have been covered so far and the collections made during the survey are being analysed. Out of the nine districts studied the deltaic regions of East Godavari, Krishna and Nellore have

been found heavily infested with weeds.

11. SOIL COMPOSITION AND FISH PRODUCTION

With a view to study the correlation between the available nutrient status of pond soil and production of fish, observations in selected ponds at Sambalpur, Berhampur, Puri, Balasore, Angul and Choudwar in Orissa were continued. Regular determination of water and soil qualities were carried out. The ponds were stocked uniformly with major carp fingerlings and production was assessed after 8 months. The results confirm the earlier observation that in slightly acidic or slightly alkalinic soils with fair concentration of available nitrogen, soil phosphorus is likely to play an important role in determining production.

A laboratory experiment using a series of glass jars was taken up to determine whether different levels of available phosphorus in soil has any effect on the production of plankton. Phosphorus was artificially raised to 8,12 and 16 units (mg./100gms.) by adding double superphosphate. Plankton was uniformly inoculated in the jars and the water conditions were studied at weekly intervals. It appears that plankton production could be directly correlated with available phosphorus. The experiments are being continued.

In a field experiment in the nursery ponds at Linghipur, starting with two different levels of phosphorus (4 & 8 units) the same trend of production as in the experimental jars was obtained. Observations in six other ponds at Linghipur showed the same trend so far as fish production during the fry stage is concerned.

Some preliminary experiments conducted in cement cisterns to find out the effect of addition of Manganese, indicate that there is difinite increase in the quantity of plankton produced when treated with trace elements. Here also it was noted that high plankton concentration coincided with high phosphorus and Manganese in water.

Results obtained from another series of laboratory experiments indicate that when the pH was lowered from 7.3 to 3.5, there was a sudden rise of phosphate in water which was more or less maintained till the end of the experiment when the pH rose to 6.8. Increase in the case of Manganese and Copper was slow and there was very little increase in the case of Iron which showed a diminishing trend when the pH reached neutrality. In the case of alkali treatment, manganese faded away to minimum when the pH was raised from 7.3 to 11.0 and re-appeared when pH was lowering down. Phosphate showed diminishing trend.

12. Miscellaneous studies

About 150 samples of plankton were analysed to find out the correlation between plankton concentration estimated gravimetrically and by photo-electric absorption through a suitable filter. The correlation curve shows a linear relation between plankton weight and photo-electric absorption in majority of cases.

Various methods of collection of plankton have been under trial in order to find out the most representative sampling technique. Appreciable quantities of silt found in most of the collections could be satisfactorily removed by fractional separation using chloroform as a coagulant.

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Observations on the formation of pearls induced by mantle grafts in the freshwater mussel Lamellidens were continued. During a period of one year the survival of operated shells was found to be about 40%. All the operated shells produced tiny pearl concretions at the place where mantle grafts were introduced. Size of the pearls ranged from 0.2 to 2.0 mm. but only a very small fraction were of regular shape.

RIVERINE AND LACUSTRINE DIVISION

13. Catch Statistics and Disposition of Fisheries in the Ganga River System

The total landings from the main river Ganga has been estimated to be 1015.7 m. tons during the period April 1960 to March 1961 as against 899.6 m. tons in 1959-60, thus registering a rise of 12.91%. The maximum catches were landed in December (147.6 m.tons) and November 138.6 m. tons) and the minimum in August (21.9 m. tons).

The yield of major carps amounted to 158.2 m. tons as against 224.8 m. tons during the previous year. The yield of C. mrigala was 62690 kgms., C.catla 50.5 m. tons, L.rohita 38.6 m. tons and L.calbasu 6.398 m. tons.

The catch of large catfishes for the current year was estimated at 290.5 m.tons. The landing of Mystus aor was 64.6 m. tons, M. seenghala 27.9 m.tons, W.attu 57.1 m.tons, S.silondia 22.5 m.tons, P.pangasius 99.5 m.tons, Rita rita 12.3 m. tons and B.bagarius 6.7 m.tons. In spite of decrease in yield from M.aor, S.silondia and B.bagarius, the large catfishes have shown an overall net increase of 10.42%.

The landing of Hilsa ilisha constituted 308.7 m.tons as against 154.7 m.tons of the last year. The total landing of prawns and shrimps was 25.5 m.tons, there being a net difference of 3.6 m.tons, registering 16.58% over the previous period. The landing of tortoise amounted to 4.7 m.tons.

The annual landings in the Jumna river has been estimated to be 312.7 m.tons as against 545.3 m.tons in the previous year. The landing of major carps amounted to 158.2 m.tons which was less than that in the previous year (1959-60) by 124.6 m.tons. The fishery of C.mrigala amounted to 97.9 m.tons, C.catla 22.8 m.tons, L.rohita 23.7 m.tons and L.calbasu 13.8 m.tons.

The landing of large catfishes amounted to 102.2 m.tons as against 183114 kgms. of preceding period. The fishery of M.aor constituted 40.9 m.tons, M.seenghala 18.4 m.tons, W.attu 15.5 m. tons, S.silondia 9.4 m.tons, P.pangasius 6.4 m.tons, R.rita 6.9 m. tons and B.bagarius 4.7 m.tons.

The landing of Hilsa amounted to 24.1 m.tons as against 28.0 m.tons of 1959-60. The landing of prawns and shrimps constituted 0.9 m.tons.

14. Catch statistics of Narbada River.

The sampling technique of market survey for estimation of total fish production in the Narbada river was given effect in December 1960. For this purpose the stretch of 450 miles of Narbada river in Madhya Pradesh has been

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Narbada river in Madhya Pradesh has been sub-divided into three fishery zones, each about 150 miles in length. The species composition of the catches in Western zone (Khandwa to Barwani) is found to be as follows :- B.(Tor) tor (28.1%), L.fimbriatus (22.1%), M.aor (6.8%), M.seenghala (5.6%), L.calbasu (5.0%), R.pavimentata (2.7%), Ophicephalus spp. (2.6%), L.bata (1.8%), L.dyocheilus (1.2%), O.bimaculatus (0.8%), C.catla (0.4%). In the central zone (Udhiapura to Harsud) the predominant species in the catches were B.(Tor)tor (30.1%), L.fimbriatus (24.4%), M. seenghala (10.8%), M.aor (9.1%), W.attu (4.4%), B.sarana (3.5%), R.pavimentata (3.0%), L.bata (2.9%), Ophicephalus spp. (2.0%), C.mrigala (1.8%), C.garua (0.8%). In the eastern zone (Mandla to Gadarwara) the catches were represented by B.(Tor)tor (25.3%), L.fimbriatus (21.5%), W.attu (10.5%), M.seenghala (8.2%), M;aor (6.5%), R.pavimentata (6.4%), Ophicephalus spp.(4.2%), L.calbasu (3.7%), B.sarana (3.6%), M.armatus (1.9%), L.bata (1.4%), C.mrigala (1.2%), L.gonius (1.1%), C.catla (0.5%). Thus it is seen that in Narbada river fishery of B.Tor tor and L.fimbriatus is the most important, followed by M.seenghala and M.aor in Central Zone, W.attu and M.seenghala in Eastern Zone and M.aor and M.seenghala in Western Zone.

Detailed studies on the disposition of commercial fisheries were limited to a 30-mile stretch of Narbada in Central Zone which includes two important landing centres, Hoshangabad and Shahganj. In this stretch the annual catches were estimated to be 36640 kgms. The catches were represented mainly by B.(Tor)tor (26.9%), L.fimbriatus (19.0%), Rita pavimentata (15.1%), M.seenghala (8.4%), W.attu (7.0%), L.calbasu (3.3%) and M.aor (3.3%). The dominant size groups were :-

B.(Tor)tor :	230-405 mm. (50.9%);	410-610 mm. (30.7%).
L.fimbriatus:	330-455 mm. (50.4%);	180-305 mm. (38.5%)
R.pavimentata	130-200 mm. (73.8%);	
M.seenghala	280-455 mm. (33.0%);	480-635 mm. (39.3%); 600 upward (30.5%).
W.attu	480-635 mm. (42.7%).	

The observations on the catch per unit of effort in respect of cast net and long line operations were continued at Shahganj centre.

381 cast nets were operated for a total period of 3199 hours and the average catch per net per hour was found to be 0.36 kgms. (Range : 0.19 kgms. - January 1961 to 0.51 kgms. - September 1960) 1960-61, as against 0.41 kgms. (Range : 0.21 kgms.- March 1960 to 0.72 kgms. - July 1959) in 1959-60.

350 long lines were operated for a total period of 4017 hours and the catch per unit of 500 hooks per hour was 0.20 kgms. (Range: 0.09 kgms. - March 1961 to 0.31 kgms. - July 1960) in 1960-61 as against 0.19 kgms. (Range : 0.09 kgms. - July 1959 to 0.44 kgms. - August 1959) in 1959-60.

15. Catch statistics of Godavari river:

The collection of catch statistics and studies on disposition of the commercial fisheries in the Godavari were limited to a 25 stretch of the river near Rajahmundry. This section is reckoned as the most productive and during the year, 254.7 m.tons of fish were landed here. Comparative study of monthly catches shows a marked improvement in summer and monsoon. The summer fishing is essentially constituted by carps, prawns and catfish.

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Monsoon fishing was monopolished by bumper Hilsa harvest. The percentages of the groups in the annual catches were Carps 16.44% (41.8 m.tons); Catfishes, 14.86% (37898 kgms.); Hilsa 28.10% (71.5 m.tons); Prawns, 14.95% (38.0 m.tons) and Miscellaneous group, 25.65% (65.3 m.tons). Among the Carps, the fisheries of L.fimbriatus and C.mrigala were most dominant and that of M.seenghala among catfishes. It was observed that the first year groups dominated the commercial landings particularly of Carps and Catfishes and made up 38.6% of the total annual catches of these groups respectively.

16. Biological Investigations

Over 665 specimens of Mystus aor and 330 specimens of M.seenghala were measured during the year. The sex ratio in M.aor has been calculated to be 1 M : 1.3 F, and in M.seenghala 1 M : 1.7 F. The females of M.aor were found to be dominant in the months June to February and of M.seenghala in April to November.

On the basis of diameter measurements of 300 ova of each ovary, 10 arbitrary stages have been defined which correspond to the International Scale adopted for Sea fishes. The progression of the two right-hand modes have been compared by means of a scatter diagram wherein the position of the last group of most mature ova (Y) is plotted against the position of the mode of the preceding group (X) in 50 ovaries representing D to I stage of maturity. A high coefficient of correlation of 0.720 (PL 0.05) emphasises the close relationship between the progression of the succeding modes so that it is established that groups of small ova grow to maturity and will also mature in their turn within the same spawning season. The ratios of the maturing and mature ova in the ovaries of F stage has been collected month-wise and the minimum value of ratio of 1 to 0.8 in April suggests peak breeding period. Thus the multiplicity of the model groups and a high correlation between the modes of successive groups and the decrease with the advent of spawning season in the proportionate number of the ova forming the intermediate groups provide sufficient evidence that individuals of M.aor spawn more than once in a breeding season. It is seen that ovaries in immature intermediate stages are recorded almost throughout the year, although majority of immature ones are encountered in August to February. Majority of mature ovaries are recorded in the months February to July. Mystus aor breeds during early March to end of August. The collection of large number of early larval stages during the period supports this conclusion.

The minimum size at which the first maturity is attained in M.aor is above 820 mm. when the fish has entered the third year of its life. The relationship between ova number and length and weight of fish is found to be :

$$Y = 1.85027 + 1.04325 \log T.L., \text{ and}$$
$$Y = 2.53240 + 0.63993 \log W.$$

Relationship between length of ovary (Y) and length of fish and between length of testes (Yt) and length of fish is found to be:

$$Y = -1.76952 + 1.30263 \log T.L., \text{ and}$$
$$Yt = -1.07750 + 1.07687 \log T.L.$$

Relationship between weight of ovary and the number of ova spawned (fecundity) has been found to be :

$$Y = 3.60257 + 0.68189 \log W., \text{ or}$$
$$Y = 4005 \quad 0.68189$$

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The analysis of covariance and the test of significance performed for the males (4 years' samples combined) and the females for the same period yield high values of F, thereby showing that the differences in the values of 'b' for males and females are highly significant. The test of significance has also shown that the differences in the values of 'b' with different samples (Males and females separately) are highly significant.

243 stomachs were examined and the data show that the fish subsists on leteosts (58.7%), insects (27.73%), crustaceans (8.21%) and plant debris (5.36%). The feeding activity does not follow any set pattern and the stomachs examined showed generally poor feeding activity almost throught the year. Mature specimens during the period April-June were with almost empty stomachs. Monthly fluctuations in the volume of the different food items have shown that there is no selectivity in feeding habits and it is observed that absence of insects as item of diet during July to September is perhaps due to high flood conditions prevalent in the rivers. The analyses of gut contents of juveniles show that there is no marked difference in the food habits of adults and juveniles. The food habits reveal that fish is a column and marginal feeder.

Length/frequency analyses indicate that commercial fishery of Catla catla is represented by 8 year classes as follows:

Age	Mean size	Size range
I	285	270-300
II	455	440-470
III	655	640-670
IV	810	795-825
V	890	875-905
VI	950	935-965
VII	995	980-1010
VIII	1035	1020-1050

The scale length (Y) and fish length (X) show a high degree of correlation with value of r = 0.98946, and the relationship is expressed as :

$$Y = -1.638449 + 2.9141^{(10-2)}X.$$

Specimens in advanced stages of maturity occur in May and June. August seems to be the peak breeding period. There appears to be some functional relationship between number of ova and weight of ovary but the same cannot be said with reference to weight of ovary and length of fish. The fecundity of eight ovaries of weight ranging from 301 gms. to 3118 gms. was found to be between 230831 and 2963125 ova. The sex ratio for the year was calculated to be 1:1.

The food of the fish comprises mainly of crustaceans. On the basis of data arranged separately for each of the four quarters of the year, crustaceans ranged between 42.5% and 61.3%; algae 11.4% to 13.6%; plant matter 2.8% in January-March quarter to 14.4% in October-December quarter; insects 4.0% to 12.0%; Rotifers 1.4% to 11.3%. Feeding intensity was found to be low during the breeding season.

Juveniles (56-147 mm.) dominated the Silonia silondia catches at Allahabad in August and September. Mature specimens were observed during June to August and spent fish in August. Specimens with spent ovaries encountered in December, seem to indicate prolonged breeding but more evidence in this regard is

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necessary. Fecundity of one specimen (1062 mm. T.L.) with ovary weighing 252 gms. was calculated to be 487901. Age and growth is being studied by L/F method and markings on vertebrae centre. Markings seem to be indicative of age and the first ring is found after the fish has attained 173 mm. in total length. In the size range 1062-1306 mm. 7-8 rings are observed. The fish subsists mainly on teleosts (30.1 to 71.1%) followed by insects (10.1 to 41.2%), plant matter (7.2% to 11.4%) and prawns (4.4% to 8.3%).

241 specimens of Barbus (Tor)tor (size range 210-785 mm.) were examined for biological studies. The trend of feeding activity, as determined by gastrosomatic index and 'condition' of guts, has shown that the fish feeds actively from November to June (GSI: 5.1) and poorly from July to October (GSI: 1.8). This species was found to subsist mainly on macrovegetation (45.0%), molluscs (13.8%), filamentous algae (12.5%) and insects (5.1%). The macrovegetation was comprised of Vallisneria, Ceratophyllum, Naias, Hydrilla, and Chara. Spirogyra, Zygnema and Mougeotia were common among filamentous algae. Diptera larvae, Caddis fly larvae, Dragon fly nymphs and Water Bugs constituted the insect diet. The gross examination of the gonads and gonado-somatic index have shown that this species commences breeding in August and is continued upto January. The availability of large number of post-larvae of size range of 9-12 mm. from August to January and occurrence of partly and completely spent ovaries in the same period fully support these observations. The ovaries were mostly found to be maturing in April-June (GSI: 6.8), maturing and ripe in July-September (GSI:15.1) ripe and partly or completely spent in October-December (GSI: 7.0) and resting stages in January-March (GSI: 5.1). The first maturity of this species (both sexes) is attained in the size range of 270-290 mm. The fecundity of nine specimens in the size range 283-750 mm. was found to be ranging between 7000 and 100000.

The size group 125-250 mm. was the most dominant in Rita pavimentata catches. The catch per unit of 500 hooks per hour was found to be 0.13 kgms. as against 0.12 kgms. in 1959-60, when prawn, earthworm, dragon fly nymphs, fish, gastropods, wheat and filamentous algae were commonly used as baits.

The observations on the diet of adults have shown an upward trend in the feeding activities from April to July. The data on gastrosomatic index and 'condition' of stomach have shown the same trend. The fish subsisted on molluscs (37.7%), macrovegetation (6.1%), teleosts (5.6%), prawns (5.3%) and insects (1.4%). The examination of 190 stomachs of juveniles (below 125 mm. total length) from July to October has shown that the feeding activity which was intensive in July-August (av. feed : 0.05 cc.; GSI: 1.81), declined in September-October (av. feed: 0.04 cc.; GSI: 1.21). The main food items were found to be prawns (22.7%), insects (14.4%), macrovegetation (4.8%) and teleosts (1.8%). The gross examination of the gonads and the ova diameter studies have indicated that this species commences breeding in June-July as was observed in the previous year. The gonads were mostly immature and maturing in April (GSI: 1.4), maturing and ripe in June (GSI: 2.89), ripe and partly spent in July-August (GSI: 5.43 and 8.91 respectively) and spent in September (GSI: 2.48).

Prawn fishery in Godavari appears to extend upto 900 kgms. from the sea, but smaller size-groups dominate in the lower reaches and larger size groups in the upper reaches. Over 8000 specimens of Macrobrachium malcolmsonii were examined during the year. The

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length frequency analysis showed that males in the catches were comparatively smaller than females during April to September and thereafter large size groups of males dominated the catches, particularly during the period October-February. Winter and summer catches were dominated by males but in intermediate months females dominated. Females mature when they attain the length of 50 mm. during its first year. The length range of berried females observed is 52.0 to 165 mm. Fecundity appears to increase with the increase in size of the prawn and breeding commences with the onset of first monsoon rains and extends over 5 months. The data seem to suggest that females breed more than once in a single season. The incubation period is observed to be 12 days for both M.malcolmsonii and M.scabriculus.

17. Stream Pollution Studies

Studies on the impact of pollution of sugar and distillary wastes belonging to Messrs. S.K.G. Sugar Mills, Hathua and Siwan Sugar Mills, Siwan on the small stream Daha in the Siwan Sub-Division of Saran District (North Bihar) were undertaken. River Daha is a perennial meandering stream from over flow of a large Jheel (Sasamusa cher) and joins the river Gogra some 30 miles below Siwan.

Results based on eight observations indicate that during the premonsoon months except on two occasions, apparent severe pollutional conditions did not prevail. Eventhough D.O. was low (3.1 - 4.4 p.p.m.), B.O.D. value never went high (2.0 - 7.3). During the monsoon months conditions improved, but at Renua, due to admixture of distillary wastes, the river was affected for a short length (D.O. 0.05 and B.O.D. 20.0 p.p.m.). Postmonsoon months showed high degree of pollution between Renua and Singahi due to intensified bacterial activity and stagnations (D.O. 0.48 - 1.8 p.p.m. and B.O.D. 60.87 p.p.m.). The stretch above Renua did not show any pollutional features. During the next monsoon conditions, all signs of pollution disappeared (D.O. - 5.4 - 7.6; B.O.D. 6.8 - 7.2 p.p.m.) in the entire stretch. Nutrients like Nitrates and Phsphates showed high values. Since there is little flow, natural aeration does not occur, but from 4 hourly sampling analysis for D.O. over 24 hours, it appears that the thick growth of submerged vegetation contributes a high measure of D.O. helping in the purification of water.

On two occasions fish mortality occured. Distillary wastes of low pH and high oxygen demand reduce the ferric iron into ferrous state which on contact with oxygenated alkaline water is reconverted into ferric state and thereby reduce the D.O. content. Fine precipitation of ferric iron on the gills also reduce the capacity of fishes to absorb the little amount of oxygen present in the water and thus endanger the fish life.

46 species of fish were collected of whihh Ambassi nama (41.7%), Gadusia chapra (22.8%), Oxygaster bacaila (13.3%), Mystus vittatus (10.2%), Puntius sophore (10.0%), Puntius chola (10.0%), Labeo rohita (1.6%), Catla catla (0.4%) and Cirrhina mrigala (1.9%) were dominant forms. The occurrence of catfishes like Wallago attu C.garua, E.vacha and some Mystus spp. was restricted mostly to postmonsoon months and also the major carps. A decline in major fish population is directly attributable to conditions of pollutional features. The stomach analysis of 265 specimens obtained from all points revealed that they thrived mostly on the bottom biota, aquatic oligochaetes, chironomids and insects.

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Bio-assay experiments using Puntius sophore as test fish indicated that distillary effluents have toxic range between 6.03 and 8.14% when fish are 78.8 mm. (av.T.L.) and 9.23 gms. (av.wt.). Raw undiluted sugar waste did not show any toxicity even after 24 hours. Complications arise only when these sugar wastes are subjected to bacterial activity.

With test fishes P.sophore and M.vittatus of average size 73-38 mm. and 93-45 mm. and corresponding average wts. 4.2 - 0.6 gms. and 6.9 - 0.6 gms., pulp waste showed the TLm values between 23.24 - 26.99% and 31.34 - 36.41%. For paper waste and combined waste of pulp and paper, both the fishes showed similar toxic range.

18. Ecological Investigations in the river Ganga:

The ecological study in the stretch of 700 miles of river Ganga was completed by the end of January 1961. The regular collections and analysis of plankton, bottom biota, and water samples were made at all the seven collecting stations. Rise in the plankton quantity was observed from April to June. The average monthly plankton was highest in June at Varanasi (57127 per litre) followed by Allahabad (26347 per litre), Kanpur (47317 per litre), Rajmahal (7932 per litre), Ballia (3712 per litre), Bhagalpur (2135 per litre), and Patna (1321 per litre). From July i.e., with the onset of rainy season, the plankton showed a sharp decline with considerable rise in turbidity and the velocity of current. The minimum quantity of plankton was observed during September.

Chlorophyceae remained dominant at all the centres throughout the period, except at Kanpur in May which was probably due to the bloom of Nostoc and Anabaena. Most widely represented species of chlorophyceae were Mougeotia, Spirogyra, Pediastrum, Actinastrum, Eudorina, Pandorina and Scenedesmus. Bacillariaceae was represented by Synedra, Nitzochia, Nayicula, Fragillaria, Gomphonema, Gyrosigma, Diatoma and Pleurosigma. Anabaena, Nostoc, Microcystis, and Merismopedia were the important species forming Myxophyceae group.

Zooplankton also had the similar trend of rise and fall as that of phytoplankton. The maximum monthly average zooplankton was recorded in June. Zooplankton became minimum in September at all the centres fluctuating between 9 and 46 units per litre. Rotifers, represented by Anurea, Brachionus, Filonia, Polyarthra and Rattulus, were the most dominating forms. Nanplu, Cyclops among copepoda, and Ceriodaphnia and Bosmina among cladocera were obtained frequently.

The benthic organisms did not show any regularity in occurrence. The maximum number of organisms were obtained at Patna in September the value being 1110 per square foot. The other values obtained were : at Varanasi in June 661 per square foot, at Rajmahal in May 117 per square foot, at Allahabad in June 87 square foot, at Bhagalpur in July, 16 per square foot, at Kanpur in April, 5 square foot.

The average pH at all the centres was 8.1 except at Kanpur and Allahabad where the same was 8.2 due to excess of bicarbonates. The dissolved oxygen ranged between 3 to 8 ppm. Chloride showed maximum value in June (23 ppm.) and minimum (4 ppm.) in monsoon season.

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Silicate was maximum in May (19 ppm.) and minimum in July (4 ppm.)

In the Jumna a gradual fall in pH was observed from 8.0 to 7.5, due to the dilution of wastes during rainy season. Alkalinity was mainly because of bicarbonates, ranging between 50 to 156 p.pm. Inorganic nutrients such as nitrate and phosphate registered a sudden rise in July and then gradual fall from August onwards. Calcium showed maximum concentration in October (52 ppm.) minimum in July and August (15 ppm.). Before the onset of rainy season the concentration of nutrients was higher at banks than in the midstream. Nitrate showed a difference of 0.03 ppm., phosphate 0.04 ppm. and silicate 3 ppm. During the rainy season a general rise in the concentration of these nutrients was observed both in midstream and at margins.

19. Location of fish breeding grounds and Carp collection centres

Over 35000 Hilsa eggs were collected during the period 2nd July 1960 to 19th September 1960 at Piocha (20000 eggs), Malsar (15000 eggs) and Mangrol (26 eggs). This indicates that an 18-mile stretch of Narbada between Poicha and Mangrol constitutes spawning ground of Hilsa. This confirms the earlier obervations made, during the previous year. Indications are that spawning season of Hilsa commences in June-July and continues upto September with peak breeding in August when the maximum flood level is attained in the river. Breeding is observed to have taken place in early morning hours between 2.0 A.M. and 6.o P.M. It is also observed that upstream migration and breeding activities of Hilsa are correlated with lunar and high flood periodicities. Males appear to ascend earlier in the seasons than the females. The length frequency data showed that older size groups penetrate freshwaters for breeding and that Narbada Hilsa attain maturity at higher length as compared to Gangetic Hilsa.

Investigations on availability of carp seed in Narbada were regularly carried out. At the three centres Poicha, Malsar and Mangrol in Gujrat State considerable quantities of seed were collected. Malsar centre appears to be quite productive and over 13050000 carp fry were collected in the 2-3 nets operated for 202 hours on 37 days. The percentage of major carps in the samples reared was calculated be 94.0%.

In the Godavari river at Rajahmundry it was observed that spawn during monsoon season is composed of nearly 37 species (excluding the catfishes) of fish. Of these six are major carps, seven minor carps, eight barbels and sixteen carp minnows and forage fishes. High percentage of major carps in the spawn occurs in July during the first two floods and spawn of L. fimbriatus is dominant throughout the season July to September. Each species tend to indicate a peak period comprising a few days when they occur in largest numbers and therefore it appears to be feasible to predict the period when maximum collections of major carps could be made.

20. Basic surveys of rivers

The inventory survey of fishing villages in the 230-mile stretch of Tapti river from Tedtalai to Kathora in Madhya Pradesh and Maharashtra state and from Nengri to Surat in Gujrat state has been completed. In the five districts so far covered there are 196 villages with a total population of 71740, of which 7415 are active fishermen. The largest number of nets were gill nets

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(11858), followed by fishing rods (5215), Hilsa jal (3441), cast net (2298), traps (1925), scoop nets (1685), long lines (1383), Bag nets (441) and Drag nets (60).

The preliminary survey of the Godavari river was completed during the early part of the year. In the 672 villages, the active fishermen population is 12854. Among the fishing gears the most important are drag nets (1208770 pieces), hook and lines (18766 nos.), cast nets (14215), dip nets (2423) and scoop nets (486). The data shows that a long stretch of nearly 345 miles between rivers Purna and Pravara is the least productive and most underdeveloped region. Among the fisheries, L.fimbriatus appears to be widely distributed and fisheries of Catla, Mrigal and Calbasu appear to be limited to lower reaches. The catfishes have much wider distribution and of these, M. seenghala, M.aor, Wallato attu, P.pangasius etc. are the more important fisheries. Hilsa fishery is restricted to lower reaches upto Dowleiswaram and prawn fishery is extremely important particularly during summer months.

The preliminary survey of the Krishna river which was initiated during April 1960, was completed in October 1960. In the 1278 km. stretch, there are 156 villages with 3030 active fishermen, 4224 cast nets, 368 drag nets, 991 gill nets, 171 dip nets and 115124 hooks. The fisheries of Krishna river are extremely poor excepting in the lower- / -most reaches.

A survey of Sardasagar, an irrigation reservoir in Pilibhit district of Uttar Pradesh and the Sarda river drainage was undertaken to investigate the problem of possible escape of major carp fingerlings through the outlet channel. The fish fauna survey, which included the evaluation of relative abundance of various species of Sarda river, Chuka nadi above and below the reservoir and Sarda-sagar, clearly showed that there is very little possibility of any large scale fish escape through the outlet channel. So it was recommended that there is no need to provide any fish screens for preventing fish escape. A detailed scheme for proper development of Sardasagar has been suggested.

21. LACUSTRINE INVESTIGATIONS

During the year under report 21.16 metric tons of fish were estimated to have been sold in the Hospet fish market. Carps predominated during June to November. During other periods siluroids predominated. Barbus spp., 40.61%; (of this B.kolus formed 30.7%); Labeo spp., 23.1%; Siluroids 33.9%; Murrels and others 3% were the other important groups. The peak periods of production were September - October/November and March - April.

Length frequency data analysed indicated that unimodal curves are given by B.kolus, S.silondia, B.pinnauratus, B.pulchellus, Labeo calbasu and L.potail. Multimodal curves are given by L.fimbriatus, B.dobsoni, B.tor, Wallago attu, Mystus aor and M.seenghala. Further observations are being made to find whether this is due to selectivity of gear or predominance of certain age groups.

Average catch per month(species-wise) is as follows:- B.kolus 528 kgms., B.dobsoni 88.7 kgms., B.pinnauratus 42 kgms.,

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B.tor 28 kgms., B.pulchellus 11.2 kgms., L.fimbriatus 316 kgms., L.calbasu 44.3 kgms., L.potail 25 kgms., L.nukta 4.3 kgms., Mystus aor 248 kgms., M.seenghala 144 kgms., W.attu 36.6 kgms. and Silonia silondia 29 kgms.

Fishing in the Reservoir was done for 615 days. Departmental Uduvalai nets of 1.5" and 2" mesh and Rangoon nets of 2.5", 3" and 3.5" mesh were used for this purpose. From end of November onwards, the Rangoon nets prepared by Mr. Gulbadamov (F.A.O. Expert) were employed and these increased the catches considerably. The composition of catches (by weight) was as follows : B.kolus 1.5" - 67%, B.pinnauratus 1.5" - 95%, B.dobsoni 2.5" - 31%, B.tor 3.5" - 76%, Rohtee vigorsii 1.5" - 100%, B.pulchellus 2" - 41%, Labeo calbasu 2" - 48%, L.fimbriatus 2" - 43% and Mystus seenghala 2" - 55%.

Sex ratio in most of the species were 1:1 or 1:1.5 (male:female) but in Rohtee vigorsii it was 1 (m) : 18 (f) and in M.seenghala 1(m) : 3(f). The number of eggs and their size frequency have also been studied. Length-weight relationship and relative condition factor was calculated for six species. Growth rate was studied in L.potail, L.nukta, Scaphiodon thomasi, B.dubius, B.carnaticus and Cirrhina cirrhosa by means of observation of scales. It was seen that Neotropius khabalchor feeds on the scales of the carps and this may be responsible for many regenerated scales found in the fish from this reservoir. This fish takes to feeding of scales when over 1.5" in length.

An interesting observation has been observed regarding Rohtee sp. Small fish (upto 6" long) of this species are eaten by siluroid fishes. The dorsal spine of Rohtee is erected and gets stuck up on the gullet of the predator and this keeps the mouth of the latter open and in course of time it dies. During December and January many siluride (Silonia silondia, Mystus aor and Mystus seenghala) were found floating dead in the reservoir. Invariably all these fishes had Rohtee stuck up in their gullets.

During the greater part of the year (from April to October 1960), the Unit took part in experimental fishing conducted by F.A.O. Gear Technician Mr. Gulbadamov in Mettur Reservoir, Krishnaraj Sagar and Maithon and Panchet hill reservoirs. Surface gill nets (2" - 5" mesh), bottom-set gill nets (1.5" and 2") and monofilament nets were used. The nets, which are modifications of the local Rangoon and Uduvalai nets, gave comparatively better catches. Data on length, weight, sex etc. were collected from fishes caught in different meshed nets.

The catches obtained by the modified nets at Mettur Dam were more than double that caught with local gear. Cirrhina cirrhosa, Pangasius pangasius, Silonia silondia and C.mrigala contributed mainly to the catches. The average sizes (in mm.) of these species obtained in different nets were :

Species	Mesh - 2"	2.5"	3"
C.cirrhosa	499	498	511
C.mrigala	556	441	696
Silonia silondia	389	416	463
Mystus seenghala	487	-	854

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Nets with 2" - 5" mesh were used in Mettur and Panchet reservoirs. Mrigal formed 20.7% of the catches, L.calbasu, 23.4%, B.sarana 19.2%, Wallago attu 9% and Catla catla 7.6% and Rohu 7.3%.

Fishing with Electric lamps, using red, orange, blue, green and yellow lights was done, but this did not prove successful for large scale fishing. Fishing with electric current was also tried at 5-40 volts, but this experiment also did not give expected results.

At Krishnaraj Sagar experimental fishing was done during July and August. The catch per net per day in different meshed nets were follows :

Rangoon net 2" - 11.16 kgms., 2.5" - 12.57 kgms., 3" - 6.88 kgms., 3.5" and 4" - 2.99 kgms. and 4.5" and 5" - 0.952 kgms, and Uduvalai nets of 1.5" and 2" - 3.26 kgms. Barbus dubius and B.carnaticus contributed mainly to the fishery. The average sizes of the two species obtained in different nets were:-

	2" mesh	2.5"	3"
B.carnaticus	456	524	586
B.dubius	398	470	524

Plankton studies conducted in the Tungabhadra reservoir indicated that zooplankton predominated over phytoplankton. Among the zooplankton, the order of predominance was Copepoda, Rotifers and Cladocera. Among the phytoplankters the order was Green algae, Diatoms and Blue green algae

The maximum surface temperature of the reservoir water recorded during the year was 32°C. and minimum 23.8°C. The difference of temperature from surface to bottom during February - May period usually exceeded 2.5°C. while during the rest of the year, it was rarely more than 1°C. No permanent thermocline formation was observed. The pH varied between 8.4 in June to 7.3 in August. The maximum turbidity recorded was 104" in February and the minimum 4", in August. The maximum dissolved oxygen content noted at surface was 8.0 mgs./1. in January and the same at bottom was 7.70 mgs./1. in February. There was an enormous increase of phosphates and nitrates during August when flood water entered the reservoir.

ESTUARINE DIVISION

22. Investigations on the fisheries of the Hooghly-Matlah estuarine system.

Intensive studies on the 26 selected species of fishes and 5 of prawns were continued. A study of the variation patterns of effort and catch per unit effort between centres of the same zone and days within centres has shown that the variation in the former is much higher than in the latter. Therefore, the number of sampling centres was increased from three to four per zone, with a simultaneous reduction in the number of sampling days from three to two in a fortnight per centre. The combination of sampling survey and total enumeration methods was again

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employed for estimating the total catch and catch per unit of effort in this estuary.

Compared to that of the previous year, there has been a fall in the total fish landings from this estuarine system during the year under report. This fall is essentially due to a marked fall (about 33%) in the winter season catches from the lower zone of the Hooghly around Fraserganj. The data obtained are tabulated below:

	Zone-wise annual total catch figures	
	Wt. in metric tons	Percentage
Zone I (Hooghly-upper zone)	399.7	11.6
Zone II (Hooghly-Middle zone)	147.8	4.3
Zone III (Hooghly-lower zone, plus all other lower Sunderban areas)	2,238.9*	65.0
Zone IV (Rupnarain estuary)	558.4	16.2
Zone V (Matlah-at Canning)	99.0	2.9
Total :	3,444.7	

(* This figure does not include the landings at Raidighi and Hasnabad for the period July 1960 to February 1961).

Zone-wise and gear-wise annual catch-per-unit-of-effort figures in Kgms. and gear-wise annual total catch in M. tons.

Gear	Hooghly Zone I	Hooghly Zone II	Hooghly Zone III	Rupnarain Zone IV	Matlah Zone V	Entire estuary	Total Catch	Percentage
Bagnet	6.68	2.88	198.32*	6.82	15.84	6.39 +	2,549.5	74.0
Purse net	0.58	0.83	-	-	-	0.64	51.2	1.5
Trawl net	2.18	1.56	-	-	-	2.15	67.3	1.9
Set Barrier	9.02	-	304.92*	-	6.89	7.76	140.3	4.1
Drift net	1.40	1.24	-	1.15	-	1.20	90.1	2.6
Cast net	1.22	-	-	-	-	1.22	5.4	0.2
Lift net	2.94	0.46	-	-	5.18	2.51	24.6	0.7
Seine net	-	0.54	-	4.01	7.53	4.55	68.3	2.0
Traps	0.41	-	-	-	-	0.41	10.2	0.3
Hooks & lines	0.66	0.66	-	2.52	2.62	0.68	160.8	4.7
Tangle net(kochaljal)	-	-	-	-	-	-	134.7	3.9
Miscellaneous	-	-	-	-	-	-	142.3	4.1

*From winter fishing only.

+Data of zone III are not included.

Contd....p/22.

From the above tables, it could be seen that the maximum catches were from Zone III (including all the lower Sunderban areas), contributing to 65% of the total catch, as against 75.3% the previous year. There was considerable improvement in the landings from Zone II and specially IV, while there was a fall in Zone I. The last quarter was most productive taking the entire estuarine system as a whole, as well as with regard to Zone I, III and IV. But the I and II quarters yielded the maximum catch in zones II and V respectively.

Bag net catches constituted 74% of the total catch, of which the maximum quantities were landed during the winter months November - January. Of the total bag net catches, about 66% was landed from Zone III. There was also a good bag net fishery in Zone IV.

The Clupeoids from an important component of the fisheries of this estuary, specially because of heavy catches of Hilsa, the other important species being Setipinna phasa, S.taty, Coilia borneensis, C.ramcarati and Ilisha elongata.

Setipinna phasa afforded, as usual, a fishery of some importance in the upper and middle stretches of the Hooghly and the Rupnarain estuary, but it was almost non-existant at Canning on the Matlah. Taking the year as a whole the juveniles of the '0' year group (modal length 75 mm.) dominated the catches. From March to July the fishery was restricted to the above regions and there was a predominance of juveniles throughout this period. August to October were lean months for this species, but during the winter months November to February, the fishery spread out all over the Hooghly and Rupnarain and was clearly dominated by maturing adults (modal length 135 mm.). This marks the active breeding period of the species, when fresh recruitment to the stock takes place. Breeding continues, with less intensity, up to June and during this year it seems to have commenced earlier in Rupnarain than in the Hooghly.

Setipinna taty afforded a fishery of some standing only during November to April. It was in the main confined to the lower zone of the Hooghly and other lower Sunderban areas. To a lesser extent the fishery also existed in the middle zone of the Hooghly and at Canning on the Matlah, but there was practically no fishery for this species in Rupnarain this year. Maturing adults (modal length 125 mm.) dominated the catches from the Hooghly, while at Canning the catches consisted essentially of juveniles (modal length 65 mm.).

During the period March - August, the fishery, consisting mainly of immature individuals was largely confined to Canning on the Matlah. It shifted to the lower zone of the Hooghly in the succeeding months September to November and consisted mainly of maturing adults. The fishery improved considerably in the last quarter, specially in the lower zone of the Hooghly and to some extent at Canning and it spread also into the middle zone of the Hooghly. This quarter marks the active breeding period of this species. The catch of the species during this period formed a substantial part of the total winter catches in the lower zone of the Hooghly.

Contd....23.

Coilia borneensis is fished mainly from the Rupnarain and Matlah estuaries and to a lesser extent from the middle zone of the Hooghly. Taking the year as a whole the juveniles (modal length 48 mm.) dominated the catches, contributing to about 56% of the total catch. Maturing adults (78-108 mm.) appeared in the catches from about the end of March to September at Canning on the Matlah and from March to June in the Rupnarain estuary. The spawning period thus appears to extend from March to September, with the months April, May and June constituting the peak period. However, a few gravid specimens obtained from the middle and lower zone of the Hooghly during the November to January, indicate the possibility of the existence of a different race of this species breeding during this part of the year. On an average this species seems to register a growth of 7 mm. per month during the first year of its life. It's fecundity was found to vary from 598-2558.

Coilia ramcarati affords a fishery of some importance only in the winter months in the lower zone of the Hooghly. Unlike the other species, the fishery for this species is dominated by big-sized maturing adults (78-215 mm.) and it seems to spawn during the winter months December - February in the lower zone of the Hooghly. The fecundity of this species varied from 1939-13850. As in the previous years, the Ilisha elongata fishery consisted almost wholly of juveniles (26 - 70 mm.) and was spread over all the zones, with the Hooghly forming the more important fishing ground. This species appears to have a perennial breeding habit.

The perches from another important constituent of the Hooghly-Matlah catches, with Lates calcarifer and Sillago panijius being the more important species. The fishing for L. calcarifer existed only in the lower zone of the Hooghly and other parts of the lower Sunderbans and individuals in the catches ranged in size from 75-900 mm. There were about seven size groups, with their modal lengths at 130,190, 250, 330, 410, and 630 mm. stages. S.panijius was represented in the catches of all the zones throughout the year. Individuals varied in size from 35-400 mm., with the 205 mm. size group constituting the majority. There were roughly seven size groups, their modal lengths being 45, 75, 135, 205, 285, 335 and 385 mm. The 0 year group(modal length 45 mm.) predominated the catches during the winter months of November and December. The catches were very poor from June to August.

Mugil tade and M.parsia were represented in the catches from all the zones, except the upper zone of Hooghly and from the Saptamukhi and Ichamati estuaries. The individuals of M.tade catches ranged in size from 15-560 mm. As many as nine size groups could be made out, their modal lengths being 45, 105, 155, 215, 275, 335, 375, 416 and 485 mm. Of these, the 155 mm. group was the most predominant. The winter catches were dominated by the 215 mm. and 275 mm. groups. M. parsia was available in about five size groups, their modal lengths being 45, 85, 125, 165 and 215 mm. with the first and the third groups predominating during November, December, April and May.

Harpodon nenereus constituted the major constituent of the Hooghly-Matlah-Rupnarain catches. It was available almost throughout the year in the middle and lower zones of the Hooghly and in the Rupnarain and Matlah estuaries. In the winter fishery around Fraserganj, this species formed 65% of the

Contd... p/2

season's total catches, as against 47% of the previous year. The size ranged from 20-380 mm. with about 6 size groups, their modal lengths being 85, 115, 165, 215, 275 and 325 mm. respectively. The '0' year group (modal length 85 mm.) predominated the catches from March to October, while during the winter months the fourth size group (modal length 215 mm.) was the most dominant. Large quantities of the latter size group were landed at the lower zone of the Hooghly.

The Sciaenids, comprising in the main Pama pama, Sciaenoides biauritus and Sciaena miles, also contributed substantially to the total catch. P.pama which was the most predominant of the three, occurred in the catches from all the zones of the estuary during different months of the year. 0, I and II (modal sizes 25; 125 and 205 mm.) year groups contributed to the catches from the upper and middle zones of the Hooghly and Rupnarain during the months March to May. During the rest of the months II and III year groups (modal size 345 mm.) formed the fishery in the lower zone of the Hooghly and lower Sunderban areas. Adults, belonging mostly to the III year group, in an advanced stage of maturity and spent condition occured mainly in the upper and middle zones of the Hooghly and Rupnarain during January and February and June to August. '0' group individuals dominated the fishery in the summer and rainy seasons whereas the II year group was abundant during winter.

S.biauritus and S.miles were comparatively poor and were fished mainly from the lower Sunderbans during the winter months. They were also available in the middle zone of the Hooghly and in the Rupnarain and Matlah estuaries. Both were represented by three size groups, with their modal lengths at 65, 85 and 115 mm. levels in the case of S.biauritus and at 35, 75 and 125 mm. levels in the case of S.miles.

Eleutheronema tetradactylam and Polynemus paradiseus constituted the major portion of threadfin catches. E. tetradactylum, ranging from 21-500 mm., was represented in the catches by four size groups, their modal lengths being 130, 190, 290 and 410 mm. respectively. Of these, the bigger size groups (of modal length 190 mm. and above) were caught mainly from the lower Sunderbans during the period January-March, while the younger size group (modal length 130 mm.) was common in the middle zone of the Hooghly and at Canning on the Matlah during August and September. At Itindaghat on Ichamati juveniles (modal length 120 mm.) dominated the fishery throughout the year. P.paradiseus (26 - 305 mm.) was represented in the catches by four size groups, with their modal lengths at 60, 130, 190 and 255 mm. respectively. The winter catches in the lower Sunderbans at Canning on the Matlah and at Itindaghat on the Ichamati consisted mainly of bigger size groups (of 130 and 190 mm.), while juveniles (modal length 60 mm.) dominated the winter catches in Rupnarain and during June and July in the upper and middle zones of the Hooghly. Maturing and mature adults (modal length 140 mm.) appeared in the catches at the upper and middle zones of Hooghly from April to June and from May to July in the Rupnarain, which form the spawning grounds during this period.

The Ribbon fish fishery, consisting essentially of Trichiurus savala and T.haumela, showed considerable decline during the year. The catches were almost confined to the

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lower Sunderban areas during the winter months. The Ribbon fish catches during this year's winter fishery around Frasergunj constituted only 5% of the total catch. T.savala was represented in the catches by four size groups (modal vent lengths at 57, 83, 113 and 163 mm. respectively) in the lower zone of the Hooghly and by one size group of juveniles (modal vent length 57 mm.) in the middle zone of the Hooghly and in Matlah. T. haumela, represented by two size groups (modal lengths 70 and 120 mm.) was almost confined to the lower zone of the Hooghly, with a few stray individuals in the Matlah and Rupnarain.

Catfishes formed an important group, Pangasius pangasius, Tachysurus jella and Osteogeneiosus militaris being the more important species. Four size groups of P.pangasius representing 0 to III year groups contributed mainly to the fishery in various zones of the estuary. 0 and I year group fishes formed the bulk of the landings in the upper and middle zone of the Hooghly and Rupnarain, whereas the bigger size groups were abundant in the catches of the lower zone and lower Sunderbans. T. jella was represented in the catches from the lower Sunderbans during the months August-January by individuals ranging in size from 600-900 mm. Smaller size groups representing I and II year classes (modal lengths 115 and 205 mm.) contributed to the catches from Rupnarain and middle zone of the Hooghly. O.militaris was represented in the catches from the lower and middle zones of the Hooghly and Rupnarain during the period March to July by I to III year groups. 0 year class individuals, along with II and III year classes, contributed to the fishery in the lower Sunderbans during winter months. Observations during the current year confirmed the conclusion that the fish spawns in the middle zone of the Hooghly and Rupnarain during summer months.

The prawns formed a substantial part of the total catch from this estuarine system. However, its proportion in the winter fishery catches around Frasergunj fell considerably during the year. Of the five selected species, Palaemon mirabilis Leander styliferus and Metapenaeus brevicornis were landed in larger quantities. As in the previous year, P.mirabilis continued to dominate the catches in the upper and middle zones of the Hooghly all through the year. Small juveniles (11-20 mm.) were represented in the catches from August to March, and juveniles of 13 mm. and over occurred in all the zones. Berried and maturing females occurred all the year round. Females in early stages of maturity were obtained from the upper and middle zones, while those in the final stages of maturity occurred only in the lower zone of the Hooghly. This species was represented by three size groups, their modal lengths being 25 mm. (June and August-December), 35 mm. (April-July) and 45 mm. (all through the year). L.styliferus was represented mainly from the catches of Matlah and lower zone of the Hooghly by five size groups, their modal lengths being 29 mm. (March-April and October-November), 42 mm. (January-October), 60 mm. (February and April to December), 75 mm. (October-May) and 87 mm. (December to April). This species seem to have a prolonged breeding season from September to June, the peak period being the winter months. Juveniles below 45 mm. were commonly fished from the Matlah and to a lesser extent from the lower zone of the Hooghly, while all the adults above 70 mm. were caught only from the lower Sunderban areas.

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M. brevicornis constituted the most abundant species of prawns in the Lower Zone of the Hooghly and in the Matlah and was present also in the Rupnarain estuary. It was represented by six size groups, their modal lengths being 38, 47, 59, 89 and 101 mm. respectively. Large-sized males and females occured in the lower zone of the Hooghly, while juveniles below 60 mm. were quite common at Canning, the upper reaches of the lower zone and the middle zone of the Hooghly and in Rupnarain. Specimens with maturing or mature gonads were not seen in the samples.

P. carcinus was represented by juveniles (47-116 mm.) mainly in the upper zone of the Hooghly during the months of July-November and by maturing and mature female adults (128-210) mainly in the middle zone from December to June. Large-sized males (106-202 mm.) also occurred in the middle zone, but they were all found to be immature, It is noteworthy that mature adult males and juveniles below 46 mm. were not met with in the catches. P. malcolmsonii ranging from 25-120 mm. was caught mainly from the upper zone of the Hooghly and to a lesser extent from the middle zone. Only juveniles and adult females were represented in the catches. The spawning period of the species was spread over the period June to August.

23. Investigations on the fisheries of the Mahanadi estuarine system.

A market survey of dry and fresh fish for estimating the total fish production from the estuary and a separate water zonation sampling programme for estimating the catch-per-unit-of-effort as well as the total catch, were initiated during the year.

There was marked improvement in the Hilsa fishery of the Mahanadi estuary after a lapse of several years. Heavy catches were landed from about the middle of December 1960 to the end of February 1961, with the daily catch going upto about 400 mds.

With the improvement in weather conditions in the third quarter there was considerable improvement in the intensity of fishing in the estuarine system and fairly good quantities of fish were landed. The catches continued to improve in the last quarter also, which usually marks the period of maximum fishing intensity.

Gill nets, seines, bag nets and drag nets were the commonly employed gear. The gill net catches consisted mainly of Polydactylus indicus, E. tetradactylum, Lates calcarifer, Pama pama and big-sized prawns in the Paradip-Lower Mahanadi area (Zones VI and VII) of the above, catfishes like Pangasius pangasius, Plotosus canius etc., and Setipinna phasa and Thrissocles spp. in the Jamboo-Hukitola area (Zones I, II and III), of sciaenids and catfishes in the Narayanpur-Ostar region (Zones IV and V) and of Lates calcarifer, Polydactylus indicus and Arius spp. at Jatadhar mohun (Zone VIII). The catches by seines consisted essentially of mullets, Bhetki, polynemids, catfishes, sciaenids, engraulids and prawns in the Jamboo-Hukitola and Paradip-Lower Mahanadi areas and occasionally fresh water carps like Rohu and Catla in Paradip region at low salinity period. In the Narayanpur-Ostar area the seines

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landed mainly catfishes, sciaenids, and Bhetki and occasionally some carps like Mrigal. In Jatadharmohun the seines landed mainly large sized mullets, catfishes and sciaenids. Drag-nets were operated mainly in Jatadharmohun, with the catches consisting of prawns and small sized miscellaneous fishes, mainly mullets. The same net operated in the Paradip-Lower Mahanadi area landed bigger fish like Bhetki and Sciaenids. The bag nets were operated extensively in Jatadharmohun and Hukitola regions and the catches consisted essentially of prawns.

The figures of total landings estimated from the market survey of fresh and dry fish are tabulated below. These exclude figures relating to subsistance fishing and the fish disposed off outside the markets, either by hawking or by local disposal near the fishing ground. (The weight of dry fish has been multiplied by 2.5 to get their fresh weight).

Estimates of total landings in kgms. for the year 1960-61.

	Weight of fish marketed in dried or cured condition	Weight of fish exported in fresh condition	Total Catch	Percentage
Mullets	161,055	10,237	1,71,292	22.01
Prawns	62,208	7,605	69,813	8.97
Polynimids	34,162	2,867	37,029	4.76
Sciaenids	34,338	2,818	37,156	4.77
Bhetki	17,150	12,741	29,891	3.84
Clupeoids (excluding Hilsa)	64,035	4,030	68,065	8.74
Hilsa	52,475	2,49,892	3,02,367	38.84
Catfishes	14,542	1,890	16,432	2.11
Miscellaneous	29,768	16,601	46,369	5.96
Total :-	4,69733	3,08,681	7,78,414	

The mullets contributed to as much as 22.01% of the total Mahanadi estuarine catch and were second only to Hilsa. The species contributing to this fishing were Mugil cephalus, M.troscheli, M.parsia and M.cunnesius. M.cephalus ranging in size from 15.0 - 64.8 cms. was caught mainly from the lower stretches of the estuary almost throughout the year. They were available in all the zones, except the zones IV and V and the majority were in the size range of 25.0 - 40.0 cms. The size group measuring 30.0 - 34.9 cms. constituted the modal group in June, September, October, January and February. While in April and May bigger size groups (modal length 37.5 cm. and 42.5 cm. respectively)predominated the catches, M.troscheli, ranging in size from 15.0 - 64.9 cms. were also obtained from the lower stretches of the Hooghly, but they formed a comparatively poor fishery only.

M.parsia, ranging from 7.0 - 24.0 cms. occurred in fairly large numbers in the lower stretches of the estuary, with the great majority of them within the size range of 13.0 - 18.9 cms. Taking the year as a whole, the 18.5 cm. group constituted the mode, closely followed by the 17.5 cm. group. During the monsoon months this species hardly afforded

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any fishery while big-sized individuals (modal length 18.5 cm.) were encountered in large numbers in the month of November. M.cunnesius also occured essentially in the lower stretches of the estuary and ranged in size from 5.0 - 21.0cms. It was represented in the catches mainly by two size groups, their modal lengths being 10.0 and 15.0 cms. respectively.

Lates calcarifer contributed to 3.84% of the total catch and among the fresh fish exported out, it was second only to Hilsa. It was represented in the catches by roughly about seven size groups, their modal lengths being 27.0, 39.0, 45.0, 55.0, 61.0 and 81.0 cms. respectively. The majority were within the size range of 18.0 - 45.0 cms.

The Polynemids also formed a significant portion of the total catch (4.76%). They were represented in the catches mainly by Polydactylus indicus and Eleutheronema tetradactylum, both of which occurred only in the lower stretches. P.indicus varying from 15.0 - 85.0 cms. was available in the catches from September to April, while E. tetradactylum varying from 10.0 - 52.0 cms. occured from December to May.

The Clupeoids excluding Hilsa contributed 8.74% of the total catch. They consisted mainly of Thrissocles spp., Ilisha spp., Setipinna phasa and Anchoviella sp.

24. Hydrobiological observations.

The surface water temperature in the Hooghly ranged from 21.09 - 32.08°C, while in Rupnarain and Matlah from 20.83 - 31.42°C and 20.72 - 31.20°C respectively. In the Matlah and Rupnarain, the salinity ranged from 11.80 - 28.86‰ and traces to 4.40‰ respectively. In the Hooghly three salinity zones could be distinguished, upper zone from Medgachi to Khusigoli with a range of traces to 0.6‰, a middle zone from Khusigoli to Nurpur with a range of traces to 9.92‰ and a lower zone from Nurpur to Frasergunj with a range of 1.14 to 30.10‰.

The phytoplankton production continued to be poor during the earlier part of this year. However, there was a gradual improvement in the post-monsoon months, specially in the upper and lower zones of the Hooghly. Fresh water and marine forms predominated in the upper and lower zones respectively, while both fresh water and brackishwater species were present in the middle zone and in Rupnarain. At Canning on the Matlah, the marine element was again predominant. Coscinodiscus, Melosira, Synedra and Surrirella among the diatoms and Spirogyra, Pediastrum and Eudorina among the algae dominated in the upper zone, while in the lower zone the most common forms were Biddulphia, Chaetoceros, Lithodesmium, Coscinodiscus, Triceratiun, Thallassiothrix and Trichodesmium. The main phytoplankters along the middle zone of the Hooghly and the Rupnarain estuary were Coscinodiscus, Melosira, Synedra, Nitzschia, Pediastrum, Eudorina and Spirogyra.

The Zooplankton population also showed gradual decline in the Hooghly and Matlah till the onset of rains. Rotifers (Brachionus spp. and Keratella spp.) accounted for the increase in Zooplankton population in the Rupnarain

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during this period. Quantitatively, the fresh water copepods (Diaptomus spp and Cyclops spp.) dominated the plankton in the upper and middle zones of the Hooghly and at Rupnarain, while in the lower zone of the Hooghly and in Matlah, the euryhaline copepods were found to be predominent.

25. Larval and young fish survey

The study of the distribution and fluctuations in abundance of fish eggs, larvae and young fish of the Hooghly-Matlah and Mahanadi estuaries was continued. In the Hooghly-Matlah system, larvae and post larvae of Hilsa ilisha, S.phasa, P.paradiseus, E.tetradactylum. P. pama, Coilia spp. and Mugil spp. were obtained in the various zones. Those of H.ilisha (July-November) and S.phasa (February-December) were restricted to the upper and middle zones of the Hooghly and the Rupnarain, while those of P.pama and Mugil spp. were obtained in all the zones throughout the year. Larvae and post larvae of P.paradiseus were seen in the collections of zone I, II, III and IV from April to November, while those of E.tetradactylum from March-August in zones III, IV, V and the lower reaches of zone II. Larvae of Coilia spp. were available from April-June in Zone II, III, IV and V.

In the Mahanadi estuary, the areas rich in fish eggs, larvae and juveniles were North and S.W. Hukitola, Paradip, lower Mahanadi and Jatadharmohun (Zones I, II VII and VIII) respectively). Clupeoids were the dominant group (71.7%), the rest consisting of perciformes and other orders (20.6%), carps (1.5%) and fish eggs 6.2%. Anchoviella sp. accounted for 57.1% of the clupeoids and with the sole exception of zone III, post larvae and juveniles of this species, ranging from 6.0 - 37.0 mm. were available in all the zones during June - February. Juveniles of Thrissocles kammalensis, ranging from 17.0 - 61.0 mm., formed 11.6% of the Clupeoids and their availability was almost restricted to zone III in the month of November. Post-larvae of Megalops sp. ranging from 11.0 - 33.0 mm. occured from June to August in zones II, VI and VIII. Other clupeoids met with were Coilia sp. and Corica soborna. Top-minnows and carps included Chela sp., Haplochilus melanostigma, Perilampus sp; and Labeo sp. Post larvae and juveniles of Sicydium sp. (Gobeidae) ranging from 8.5 - 20 mm. were available in almost all the zones practically throughout the year. Other larvae and juveniles encountered mainly in the lower stretches were of Ambassis sp. (7.0 -17.0 mm.), Pama pama and Sciaenoides sp. (6.0 - 8.5 mm.), Leiognathus sp. and Mugil sp.

26. Studies on the culture of Brackishwater fishes

The Brackishwater fish culture unit continued its work at the Kiragachamadeli fish farm in Orissa and carried out experiments to study the effects of different types of manurs, salinity, pH, depth, turbidity and temperature on the growth of benthic algae. The two different types of manures tried consisted of green manure (decomposed leaves of Sonneratia apetale) and chemical fertilizer NPK. Three tanks were manured with green manure at 2500 lbs/acre, four others with NPK in the ratio of 10:10:6 at the rate of 200 lbs./acre and 3 tanks were kept as controls without any manuring. Mullet fry were stocked in all the tanks at the rate of 1500 per acre. It was found

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that the benthic algae grew only during the period December to July. The mullet fry were found to grow faster in the tanks manured with NPK, than in those treated with green manure.

In order to determine the optimum salinity to be maintained in Brackishwater fish farms, pot culture experiments were carried out at Barrackpore. It was found that in most cases the concentration of ammoniacal and nitrate nitrogen in the water was highest within the salinity range 10 to 20‰, while the exchangeable ammoniacal nitrogen in the soil, after an initial gradual decrease up to a salinity of 20‰ increased with higher salinities. It may, therefore, be said that the farm water, having a salinity between 10 - 20‰, offers a better medium for the growth of floating organisms which derive their nutrients from the water, while salinities higher than 20‰ are favourable for the growth of benthic algae which depend for their nutrient requirement on the exchangeable complex.

Another set of experiments were carried out to study the influence of salinities on the transformation of nitrogen added to the soil in the form of fertilizers like ammonium sulphate, urea or sodium nitrate and to see whether Nacl can check the loss of nitrogen in the form of gas from the above fertilizers when applied to fish farms. It was found that the loss of nitrogen in 10 and 20‰ salinities was less by 30 and 40% respectively than in the 0‰ salinity and that higher salinities maintain a much greater amount of nitrogen in available form, both in soil and water than the 0‰ salinity.

27. INVESTIGATIONS ON HILSA FISHERIES OF INDIA

The second and the fourth quarters of the year formed the main fishing seasons for Hilsa. There was a fairly good monsoon fishery in the Hooghly, Mahanadi, Godavari, Krishna, Cauvery, Narmada, Tapti and the Ganga river, in the Chilka Lake, and on the Sourashtra coast.

The monsoon fishing for Hilsa in the Hooghly was confined to the lower zones in July and September and was more intensive in the upper zone in August. The winter fishery for Hilsa in the Hooghly commenced rather late, by February, and was of a short duration, the fishery coming to a close by the middle of March. Large numbers of Hilsa were caught during this period in the upper zone (near Barrackpore). The total estimated catches of Hilsa in the Hooghly-Matlah system during the period March 1960 to February 1961 was 634.16 m.tons.

In the Godavari, the monsoon fishery was of an applicable magnitude, but started later than usual commencing late in August. The maximum catches were recorded during October, when 547 metric tons of Hilsa were landed. The winter fishery in the Godavari was comparatively poor. Mostly Rangoon nets were operated during the monsoon in all the six centres sampled. In the winter season, however, nets like ailavala, Taruchuvala and Kattuvala were also operated in some centres. The catch-per-unit-effort relating to the Rangoon net, which is the main Hilsa catching net in the Godavari, in the different sampling centres was as below :-

Dowlaiswaram	....	5.63 kg.
Kotipalli	....	1.18 kg.
Bodasukkuru	....	0.79 kg.
Rajole	....	0.76 kg.
Injaram	....	1.53 kg.

Contd....p/31.

The Hilsa fishery in the Krishna was only of a small magnitude, commencing in August and continuing upto the end of October. Mostly Rangoon nets were operated. Estimated total catch during the season was 1.81 m.tons.

In the Padma, the maximum landings were recorded during the monsoon and post monsoon months. The heaviest landings were in July and October, when 128.7 and 14.71 m.tons respectively were landed. The winter catches were comparatively less, the maximum being about 64.0 m.tons in March. The total landings of Hilsa in the Padma during the year has been at about the same level as in the preceding two years. Mainly Chandijal (drift gill net), Kharkejal and Sanglajal (purse net) and Baulijal (lift net) were operated during July to March and Konajal during July to November. Occasionally the Patan jal, Ghana kona, Tana ber and Ghano ber jal were also operated. The catch-per-unit-effort pertaining to the more important Hilsa nets operated in Lalgola during the year are given below :

Chandi jal	....	4.15 kg.
Sangla jal	....	0.78 kg.
Kharke jal	....	0.43 kg.
Bauli jal	....	0.56 kg.
Kona jal	....	6.78 kg.
Patan jal	....	4.59 kg.

The total landings of Hilsa in the Ganga from Kanpur to Rajmahal during the year was 200.098 m.tons and in Mahanadi 302.37 m.tons.

The Hilsa catches in the Hooghly comprised of 0 to 5 year age groups. In the monsoon fishery the '0' and '1' year groups predominated in the catches in July and thereafter the '3' to '5' year groups. In the winter the '1' to '2' year groups were the mainstay of the fisheries.

Hilsa classifiable under the age groups 1 to 5 years formed the fishery in the Padma and the Ganga, but the majority groups in the catches were '2' to '3' years old fish. In the Godavari '2' to '5' year groups contributed to the fishery in the monsoon season (the '3' year olds predominating), while in winter the fishery was mainly for the '1' year group. In the Chilka lake and in the Mahanadi the Hilsa catches comprised mainly of fish classifiable as '1' to '4½' year age groups, the 2nd year group predominating. The Hilsa caught in the Sourashtra coast were mostly of the larger size groups measuring between 35.0 cm. and 66.0 cm. in total length.

Studies on the maturity of Gonads of Hilsa caught from Padma (in the neighbourhood of Lalgola) indicated that maturing or spent recovering fish were present in the area throughout the year. Mature Hilsa were present in the catches during the breeding seasons, the monsoon and the winter. The largest percentage of mature fish were obtained in October and March. Tow net collections made at Lalgola yielded a few Hilsa larvae in November. Since the main fishing grounds in the river (in the neighbourhood of Lalgola) lie within Pakistan, it has not been possible to demarcate the spawning area.

Samples of Hilsa obtained from the Mahanadi during January consisted mostly of spent recovering females. Of these, about half the number had empty guts. The rest were found to have fed mainly on phytoplanktonic organisms like diatoms and

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the green algae Spirogyra. Study of a large number of samples of juvenile Hilsa collected in the Hooghly showed that these feed mainly on plankton. No selectivity of planktonic organisms could be noticed. Study of the gut contents of juveniles from Godavari revealed that they had also fed largely on plankton. Among the phytoplankton, diatoms formed the chief constituents of the food. Zooplanktonic constituents included rotifers, copepods, ostracods, arachnids and larvae of crustacea, bivalves and gastropods.

The Hilsa caught in the Godavari during the monsoons were all adults. Fully mature and oozing fish were obtained during September, October and November. A few spent fish were also present in the samples during October and November. Tow net collections made below the anicut at Dowlaiswaram yielded Hilsa larvae and post larvae during November. The fecundity of Hilsa caught in the Godavari during the monsoon seasons of 1959 and 1960 have been found to vary between 5,00,000 and 11,40,000.

During the year under report, 4507 Hilsa were tagged and released in the Hooghly, the Padma and the Ganga for the purpose of studying the migration of Hilsa in these rivers and also to determine whether the Hilsa in each of the rivers form discrete populations or they intermingle to any approciable extent. With adequate publicity among fishermen and fish traders, it was possible to obtain 12.2% recoveries in the Hooghly. Due to the practical difficulties in obtaining recovered tags from East Pakistan and in paying reward to the fishermen there, the recovery from River Padma was only 4.3%. The recovery from the Ganga was 2.9%. Nearly 80% of the tagged fish were recovered within a month after tagging. The longest time interval between tagging and recovery was 770 days. The results obtained so far indicate that the fish comes up the river Hooghly for spawning more than once in its life time. The Hilsa of the winter run have been observed to come up the river for spawning in the following or subsequent monsoon seasons and vice versa. This supports the view that the Hilsa of the monsoon and winter runs do not form separate stocks. The movement of Hilsa migrating for spawning does not appear to be always upstream. However, there is evidence of greater downstream migrations during the later halves of the monsoon and winter seasons. The speed of migration appears very variable. There seems to be no movement of Hilsa from the Hooghly to the Padma or the Ganga, and very little intermingling of the populations of Hooghly, Padma and Ganga.

28. SUNDERBANS FISHERIES

Exploratory surveys of the estuarine systems of the Sunderbans, bottom contour surveys and fishing operations were continued using the exploratory fishing vessel, M.V."Sunderbans".

For the first time, the exploratory fishing operations and charting of bottom contours were conducted in the Sunderbans waters during the monsoon season also. These activities were mainly confined to the estuary of Saptamukhi and other smaller rivers and canals like Gobadia Gang, Mural Gang, Baghchira nadi and Martin's creek. Operations in other areas were not possible due to unfavourable conditions caused by monsoon. The Saptamukhi estuary was explored quite extensively and found suitable for all-weather operations.

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/lying During the winter season, the estuary known as Jagdal Gang/in between Saptamukhi and Thakuran estuaries was explored. It was found quite suitable for trawling operations between 6 to 10 fathoms line towards the lower reaches and the catches were also satisfactory. Lower reaches of Thakuran estuary near the sea face was also explored for the first time and a ground within 6 fathoms depth appeared suitable for trawling operations.

Other trawl net was mostly used for conducting fishing operations. Drift gill net (1.5" and 3" mesh) were employed on few occasions but no fish could be caught in them. From a preliminary study of the data collected during the year, it was seen that Zone II (Thakuran and Matlah) yielded the highest value for catch per unit of effort and the Zone I (Muriganga and Saptamukhi) the lowest. Altogether 213 hauls were made, catching 407 kgs. of fish from 3 Zones. Harpodon nehreus formed the main constituent and contributed 46.56% of the total landings. The catch was highest in Zone II during the winter months. The catches comprised mainly of '3' size groups having modal lengths 8.5, 15.5 and 23.5 cm. Sharks and Rays came second in order (14.89%), Trygon bleekari, T.wagla, T.sephen, Pteroplatea micrura, Carcharhinus laticaudus, Pristis cuspidatus and Rhyncobatus djensis being the species caught. Percentages of catch in the 3 zones were 16.23, 4.26 and 8.3 respectively. Sciaenids constituted 12.94% of the total landings. The group was mainly represented by Pama pama. Sciaenoides biauritus, Sciaenoides brunneus, Sciaena glaucus, Sciaena miles and Otolithus maculatus were found rarely. Sciaenids formed 18.5% of the catch in Zone I, 4% in Zone II and 11.7% in Zone III. Prawns formed the fourth big group and accounted for 9.78% of the catch, Parapenaeopsis sculptiles and Leander tenuipes being the dominant species. Cat fishes (6.88%) were represented by Arius sona, Arius nenga, Pangasius pangasius and Osteogeniosus militaris. Individuals of A.nenga and O.militaris with fertilised eggs in their mouth cavities were obtained in the Saptamukhi estuary during August and September. Arius sona contributed the bulk of total catch of cat fishes, their size ranging between 60 and 76 cm. Clupeids (3.29%) were represented by Coilia ramcarati, Setipinna phasa, Setipinna taty and Pellona motius. Muraenesonx telabonoides (2.90%) was the only eels caught and were mostly from the lower Saptamukhi, west of Lothian Island. This size varied between 58.2 cm. and 139.7 cm.

CHILKA LAKE INVESTIGATIONS

29. Fisheries of the lake

2603.6 Tonnes of fish were brought to the Chilka Assembly Centres during the year 1960. Nets with 54 different names have been encountered in the lake. Depending on the mode of operation and manner of fish capture, they have been classified into 14 types. Unstandardised state of Chilka nets is a great handicap in catch per unit of effort studies. Hence, during the year under report 5 Nos. of identical departmental gill nets made of 'Terylene' were regularly used during nights at selected centres in different sectors of the lake. Each of these nets, 152 meters X 1.8 meters, are composed of 5 pieces (30.4 m. x 1.8 m.), of mesh sizes 25 mm., 38 mm., 51 mm., 64 mm., and 76 mm. The values for monthly catch per unit of effort (catch per net per night) are tabulated below:

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Months	Catch per net per night - Gms.					
	Eleutheronema tetradactylum	Nematalosa nasus	Pseudosciaena coibor	Mystus gulio	Arius	All species pooled
April 1960	226	14	106	48	91	761
May	395	48	85	77	41	1053
June	194	47	122	216	49	1149
July	333	31	76	18	40	1113
August	235	19	37	14	-	1046
September	824	14	69	7	66	1703
October	327	8	143	7	70	1338
November	291	17	227	18	48	1442
December	244	-	68	-	34	814
January 1961	295	36	284	4	13	1317
February	285	23	303	11	21	1542
March	171	12	299	9	64	1728

The catch per prawn trap (in gms.) for the year 1960 was estimated to be, 'Daudi' - 144 and 'Bazza' - 44.

Routine observations on the species and size composition of landings at the different sectors were continued. The percentage composition of all important species have been recorded for each month.

30. Biological observations on commercial fisheries

The production of Mugil cephalus was 180.7 Tonnes in 1960. The average length of the fish was 323.8 mm. By numbers, zero and 1st year class (upto 350 mm.) have constituted 81.5, 63.4, 65.0 and 70.7% of the production during the years 1957-1960 respectively; II year class (upto 500 mm.) between 15.9% to 31.5% and year class III and above have contributed between 1.5% to 6.0%. Tagging operations have confirmed the observation that males of M. cephalus ripen and migrate to sea at age 'I' and females at age 'II' and above. Most of the recoveries of tagged fish within the lake during the period January-April comprised of immature females estimated to be I year olds. The fish breeds in the sea during the period October-December and attains an average length of 340 mm., 510 mm., and 625 mm. at the end of 1st, 2nd and 3rd years of its life respectively. Nearly 43 to 54% of the catches by weight comprise fish of the 0 and I year class, 35 to 46%, II year class and 10.5 to 20% of the III year class. Large-scale inward migration of the species was observed during May-August 1960.

33.8 Tonnes of Liza troschelli were landed during the year and the mean length was 283.9 mm. The number and weight obtained during the year, of the different year classes of specimens are given below:

Year class	Percentage values of	
	No.	Wt.
Zero and I	48.25	20.16
II	43.00	51.06
III	8.03	25.19
>III	0.72	3.59

One female specimen which measured 235 mm. at the time of tagging on 28.11.59, was recovered on 23.12.1960 and measured 398 mm. (ripe stage IV). Liza troschelli has been

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found to breed in the sea during the period January-April.

Among prawns, 575.1 Tonnes of Penaeus indicus and 298.3 Tonnes of P.semisulcatus were estimated to have been landed during the year. The average lengths were 113.42 mm. and 153.0 mm. respectively. The post-larvae of the prawns were observed to enter the lake with the tide throughout the year except during monsoon months when there is a general unidirectional sea-ward flow of fresh water throughout the lake.

193.0 Tonnes of Eleutheronema tetradactylum were landed during 1960. The fish has been found to breed in the lake with a prolonged monsoon season (January-June) with peaks in February and May. The earlier broods attain average lengths of 300 mm. and 460 mm. and the later, 275 mm. and 450 mm. when one and two years old respectively. The average length of the fish available in commercial gear was 250 mm. and mortality rate worked out to 0.71. The juveniles of the size range 51.77 mm. were found to occur in large numbers in Patua jal catches during July and formed a mode at 88 mm. class in August. The December 1959 brood, which formed a mode at 113 mm. class in May 1960 could be traced upto 188 mm. class in August. Stomach contents of the fish upto 100 mm. total length showed 65.7% Mysids, 24.6% Amphipods and 6.8% Copepods. Larger fish subsist on prawns, fish (mostly Mystus gulio) and Stomatopods (Squilla sp.)

Pseudosciaena coibor was the most commercially important sciaenid fish. 128.3 Tonnes of the fish were landed during 1960. This species breeds in the lake off Daya river mouth during April-July, May being the peak month of spawning. It attains a length of 260 mm., 410 mm. and 510 mm. at the end of the first three years of its life. 23.1% of adult females examined showed immature ovaries, 74.4% maturing and mature ovaries and 2.6% spent ovaries. Fecundity increased from 23,750 in 247 mm. specimen to 23,27,500 in 728 mm. ones. The food of the fish of size-group 76.0 to 275.0 mm., was debris and fish (30% each) and amphipods and prawns (about 17.6% each). Large fish feed on prawns (40%), stomatopods (38%), debris (20%) and fish (2%).

102.2 Tonnes, 37.0 Tonnes and 26.4 Tonnes of Lates calcarifer, Gerres setifer and Sparus sarba respectively were landed during 1960. G.setifer breeds in the lake from May to August in the Southern and Central Sectors of the lake. The minimum sizes at maturity of male and female specimens are 73 and 86 mm. respectively. The fish attains a length of 110 mm. and 175 mm. at the end of the first two years of its life.

Sparus sarba breeds in the sea from November to January, the peak months of spawning being December. The minimum size at maturity of female and male specimens are 172 mm. and 153 mm. respectively. The fish attains a length of 175 mm., 250 mm., and 325 mm. at the end of the first three years respectively of its life.

124.1 Tonnes of Nematalosa nasus were landed during the year. This fish breeds in the lake during June-July. During January-December, a regular influx of the species occurs from the sea adding to the Chilka stocks of fish. No sea-ward migration has been noticed. The fish attains 135 mm., 215 mm. and 260 mm. in the first three years of its life. The mean

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length available during the year to commercial gear was 150.4 mm. The annual mortality rate was 0.92.

Hilsa ilisha is known to ascend river Daya and breed there and also in the Northern sector of the lake. 100.6 Tonnes of the fish were caught during the year and the mean length was 262.1 mm. The average lengths attained by Hilsa in the first four years of its life have been calculated to be 150, 265, 350 and 420 mm. respectively. The annual mortality rate worked out to 0.91.

31. Physico-chemical features of the lake

Average monthly temperature varied between 22.9°C and 30.3°C, the maximum being in September and minimum in January. The pH ranged between 8.1 and 8.9, the maximum being in December and minimum in July. Transperency fluctuated between 45.1 cm. to 89.8 cm. Dissolved oxygen varied between 5.0 ppm. to 7.5 ppm. Total alkalintity was between 68.2 p.p.m.. to 109.6 p.p.m., phosphates recorded a vriation from 0.008 to 0.04 p.p.m., nitrate nitrogen, 0.015 to 0.12 p.p.m., iron, 0.001 to 0.025 p.p.m. and silica 1.8 p.p.m. to 4.1 p.p.m. Maximum salinity values ranged from 32.45‰ in the lake mouth area to 19.57‰ at Kaluparaghat. The minimum values varied between 19.57‰, in the lake mouth and 0.48‰ at Kaluparaghat.

FISH PATHOLOGY INVESTIGATIONS

32. Studies on Fish Mortality in jute-retting tanks

The biological data obtained during the year under both laboratory and field conditions have been analysed and the results generally confirmed the earlier observations. The increase in zooplankton production on applying the initial charges of jute was pronounced and the bloom was found to decrease with addition of jute. A detailed report on the investigations made has been prepared.

33. Fish Diseases and Mortality

Observations on the new type of eye disease which has caused large scale mortality of Catla catla were continued. Reports on the occurrence of the disease in some villages of Orissa State were also received. Cultures prepared from the eyes in primary stages of infection did not show the presence of any bacteria. This appears to suggest that the disease might probably be virus in origin. It is also likely that vitamin deficiencies are associated. Good growth could be obtained in media prepared with fish extract following the "trout-tissue" extract developed by Sniezko and Bridle. A few experiments were conducted by sub-cutaneous inoculation of Catla fingerlings in Glass jars, but no infection could be induced.

Incidence of 'Dropsy' disease in an epidemic form in a big tank was controlled satisfactorily. Artificial inducement of 'Dropsy' under laboratory conditions has been undertaken. Some of the attempts made were successful. The infection was induced using fluid collected from body cavities

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